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Landscape as a Focus for Integrating Human and Environmental Processes

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Abstract

The landscape has long been an important object of rural policy, particularly in terms of protecting scenic areas. Increasingly, however, landscape is seen as a multifunctional and holistic entity, which provides a framework for the governance and interdisciplinary study of spatial units. A central dilemma in the maintenance of cultural landscapes is that the historical practices which produced them are often obsolete, and new social and economic forces may fail to reproduce their valued properties. Sustainable development strategies therefore seek to instil 'virtuous' circles in cultural landscapes, linking society and economy to environmental service functions and land uses, in order to generate mutually reinforcing feedback loops resulting in socially preferred outcomes. We explore ways of investigating these linkages as a basis for future rural research and policy. We conceptualise cultural landscapes as 'socio-ecological systems' (SESs), and consider their capacity for resilience and stability. Noting that resilient systems are characterised, not by simple equilibria, but by 'basins of attraction', we argue the need to understand the ways in which SESs stabilise within a particular basin, or move to an alternative. In particular, we reflect on the dynamics of 'adaptive cycles' that may lead to changes in system state. Finally, we discuss the development of appropriate models as tools for investigating whether a landscape is trending towards stability within a 'vicious' or a 'virtuous' circle, and evaluating potential interventions to alter this trajectory.

Keywords: *Agent-based models; landscape policy; socio-ecological systems; sustainability.*

1. Introduction

Within the rural policy domain, landscape has generally been treated as a sectoral issue. Policies for the countryside have resulted in a variety of planning and

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stewardship measures which might be categorised as 'action *for* landscape'. This approach has been widely associated with the practice of designation, pre-eminently to protect National Parks and Areas of Outstanding Natural Beauty against inappropriate development. However, beyond the nationally designated areas, practice has been less consistent, and in the UK has often suffered from the use of relatively weak local designations, a heavy reliance on the land use planning system rather than a shared policy framework amongst a wider range of rural sectors, and weak and unclear central government policy guidance (Punter and Carmona, 1997).

Over the past 20 years or so, this rather narrow, albeit important, perspective is being replaced by a wider view of landscapes as spaces, places and networks where environmental service functions, food/water/timber supply, and residential and recuperative attributes are integrated. Landscapes, therefore, might also serve as a framework for scientific analysis, data capture, policy delivery, and social and economic activity. It was the work of landscape ecologists that was particularly influential in promoting this view, which initially resulted in a predominantly biological bias (cf. Farina, 2005). However, there is now a wider body of experience acknowledging the necessity of such a perspective in fields of activity which include water catchment planning, area-based delivery of nature conservation, locally oriented rural development, and countryside character assessment as a basis for land use planning. The most extreme expression of this approach is 'bioregionalism', in which natural environmental units (such as water catchments) serve as the decision-making framework for all productive and regulatory activities. This purist position, however, is only one possibility. Meadowcroft (2002) describes more flexible and pluralistic options which exploit the benefits of 'natural units' in appropriate situations, whilst acknowledging the continuing role of existing political-administrative units. Increasingly, therefore, there are opportunities to take 'action *through* landscape', recognising its holistic system properties, rather than the previous 'action *for* landscape' approach. This more sophisticated perspective is reflected in the European Landscape Convention, which promotes complementary practices of planning, protection and management (Council of Europe, 2000).

Of particular relevance is the acknowledgement of the need for active land management in the maintenance and production of valued cultural landscapes, given that the 'cultural' landscape can frequently be equated with the 'agri-cultural' landscape (Piorr, 2003) due to the centrality of farming and land use practices in the creation of qualities such as character, distinctiveness, and ecological diversity. However, the main paradox facing cultural landscapes today is that they are often highly valued by society in their inherited form, yet this form typically derives from obsolete practices which are no longer viable. The drivers of change include agricultural modernisation, alongside other economic activity such as built development and highways, natural (and human-induced) pressures such as climate change, as well as the effects of public policies. Further, the forces that produced valued landscapes tended to be local, whereas contemporary drivers often reflect more global economic and social trends. These globalising forces can be sufficient to endanger the inherited patina of accumulated culture, leading to homogenisation and 'banalisation' of landscapes. Society, however, appears to prefer certain rural qualities, and value judgements are often attached to particular landscape types. Thus, the current situation in some areas may be perceived as a 'vicious circle' characterised by obsolescence of traditional production, processing and marketing methods, and which could result either in extreme intensification or virtual abandonment. This

circle is typified by losses of properties which presently are socially preferred – such as visual character, food traceability, shared memories, actual or perceived food quality, biodiversity, and farm-based employment.

In line with commonly used sustainable development terminology (e.g., Powell *et al*., 2002), we would argue that the role of landscape policy should be to promote a 'virtuous circle', in which the social value of characteristic 'place qualities' can be realised through their utilisation in economic and social activities. In this way, a 'landscape premium' emerges in which people benefit economically from doing things that enhance multiple landscape functions, which, in turn, supply further services that enhance quality of life and economic opportunity. For example, in England, higher levels of agri-environment support under the Common Agricultural Policy are to be targeted through Joint Character Zones in order to reinforce features that are critical to distinctive landscapes. Agricultural policies are not the only basis for driving such virtuous relationships–criterion-based town planning policies based on countryside character assessments (Martin, 2004), and regional economic policies which promote originality in products and services (e.g., Barham, 2003), provide other examples.

However, while there is probably broad agreement that virtuous cycles are desirable characteristics of landscapes and rural communities, it is far from clear what policies and measures are required in order to establish and maintain them. Moreover, care needs to be taken that virtuous circles in one sphere of activity do not inadvertently result in undesirable developments elsewhere. For example, establishment of a vibrant tourist industry, while bringing a measure of prosperity to an area, could result in gradual environmental degradation. Further, as landscape values tend to be protectionist and conservative, and may be unsupportable in a context of globalisation, we may need to challenge them. This will require us to search for new understandings of 'virtuosity' which relate to different value judgements, perhaps emphasising sustainability rather than aesthetics.

What is needed are approaches and tools incorporating the social, economic and biophysical components of landscapes which can be used to evaluate and test different proposals and policies before they are implemented. In recent years, a large number of integrated assessment models linking the human and biophysical components of particular systems have been developed to address this need. However, not only have these models been based on economic cost–benefit principles that attempt to optimise use of resources such as capital or labour to maximise a particular output, but they have also tended to be developed as decision support systems without recognising that the processes of decision making and the participation of stakeholders and people is critical in both characterising the costs and benefits, and choosing between alternatives. In this paper, therefore, we discuss emerging alternative modelling approaches which could be used to explore preferred change in cultural landscapes, and provide rigorous testing of potential interventions without the time, expense and moral implications of altering real systems.

2. Conceptualising Human–Environmental Interactions in Landscapes

2.1. Landscapes as socio-ecological systems

A useful concept to describe landscapes in this context is that of a 'socio-ecological system' (SES), which takes the view that social, economic and biophysical compo-

nents considered in isolation can each only provide a partial understanding at best, and that all three aspects must be taken together to obtain a fuller understanding (Berkes *et al*., 2003). In this approach, landscapes are 'open systems' operating far from equilibrium (Kay *et al*., 1999), with material, energy and information flowing both into and out of them. It is the way in which their internal social, economic, and biophysical components are organised in relation to one another that determines how these flows are used and traded. This implies that humans should be seen as integral parts of landscapes. By contrast, many models currently tend to represent humans either as impartial observers, as external drivers on ecosystems (but not influenced by them), or as users of the environment (but not influencing it).

2.2. *Socio-ecological system dynamics*

What are the dynamics of such socio-ecological systems? The 'adaptive cycle' concept put forward by Gunderson and Holling (2001) sees such systems cycling through various phases (Figure 1). In the *exploitation* (*r*) phase resources are accumulated as the system increases rapidly in capital, while in the *conservation* (*K*) phase the system consolidates this accumulated capital by strengthening linkages between the various components. This is often followed by a *creative destruction* (Ω) phase, in which the increasingly fragile system disintegrates in response to external shocks and pressures, releasing the accumulated capital. The components making up this capital then enter a *reorganisation* (α) phase to become available for the next phase of exploitation. Thus, there is explicit recognition that change is an intrinsic property of SESs, and that static equilibrium states are seldom reached. Borrowing from complex adaptive systems theory (e.g., Prigogine, 1976), Walker *et al*. (2004) have taken the adaptive cycle idea further by conceptualising SESs as complex systems which self-organise within *basins of attraction*. A basin of attraction is the full set of system states in which the system function and form do not differ substantially. A system at any point in time will be typically located within a particular

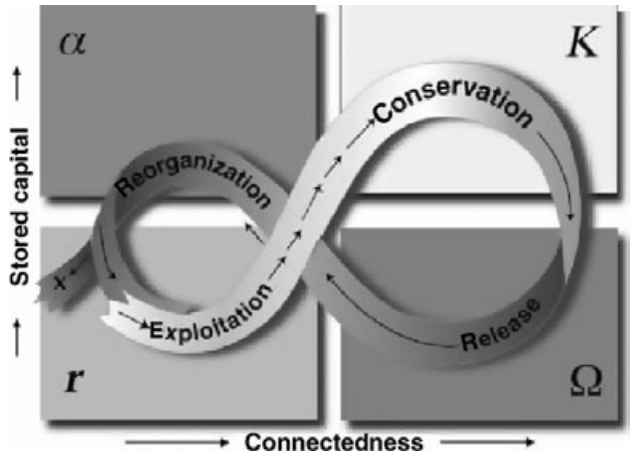

Figure 1. Schematic diagram of the adaptive cycle.
From Gunderson and Holling (2001). Stored capital can be thought of as the 'potential' or size of the system, while 'connectedness' represents the degree of interdependence between the components of the system.

basin, but over time is hypothesised to move through its adaptive cycle within that basin. However, external perturbations at critical times may, depending on circumstances, transform it into a neighbouring basin representing a significantly different set of system states, particularly if it is close to a critical threshold of a particular variable (Walker and Meyers, 2004). An example is the sudden shift from 'desirable' grassy to 'undesirable' wooded systems or bare soil in savannas and rangelands when a threshold density of grazing animals is reached (Walker and Meyers, 2004).

The concept of system *resilience* is used to describe the amount of effort required to move from one basin of attraction into another, and differs therefore from traditional definitions of the time taken to return to a previous equilibrium value following disturbance to a system. The *adaptability* of the system is the degree to which the components of the system can influence its internal dynamics and hence its resilience. Basins of attraction, resilience and adaptability are merely system characteristics; intrinsically they are neither good nor bad. It is only when particular basins of attraction are considered more desirable than others that the concept of value enters. The notion of *sustainability* can then be thought of as the process of maintaining the system in a desirable basin (i.e., avoiding transformation into undesirable basins). Resilience may, therefore, be advantageous if the system is already in a desired basin of attraction (e.g., conservation of a particular habitat), but disadvantageous if attempts are being made to move it from an undesired basin of attraction. An example of the latter would be slowness of uptake of agri-environment schemes due to farmers' reluctance to change their mode of farming (Burton, 2004).

The exploitation phase of the adaptive cycle could be thought of as the development of the 'virtuous circle' described above, in which the system is growing by building up capital and establishing interdependencies between its components (see axes in Figure 1). Eventually, however, the system may reach a point where it ceases accumulating capital, and due to the strength of the links between the components of the system making it brittle and vulnerable to external shocks or pressures, a creative destruction phase and eventual reorganisation may be precipitated. A 'vicious circle' would ensue if this reorganisation involved a transformation into a different and less desirable basin of attraction.

Adaptive cycle patterns have been discerned in several SESs (for examples, see Gunderson and Pritchard 2002; Allison and Hobbs, 2004). An example of such dynamics in a historical Scottish context is that of the 18th–19th century highland clearances, in which an external perturbation of increased wool prices resulted in a major shift from crofting agriculture to extensive sheep grazing with dramatic consequences on the social, economic and ecological capital (and hence landscapes) of significant areas of Scotland (Richards, 2000). This can be thought of as a transformation from a basin of attraction representing crofting to a new basin of attraction representing grazing, passing through the Ω phase (e.g., forcible removal of the crofters from the land), α phase (e.g., reorganisation of a proportion of the crofting community into other occupations related to sheep production), and r phase (e.g., growth of the new sheep industry) of the adaptive cycle. The persistence of the resulting SES in many of these areas for nearly two centuries would suggest that, under the prevailing socio-economic conditions, it has a high degree of resilience (i.e., its basin of attraction is relatively 'deep').

Other basins of attraction could be identified (at least in principle) for other parts of Britain and elsewhere. However, it is conceivable that current rural policy

reform, climate change, and pressure from other drivers such as demographic trends, public demand for recreational landscapes, and trade liberalisation, are moving these systems into new social, economic and ecological basins. It is not yet clear whether this is the case, and if it is, what the nature of the new basins of attraction will be and whether or not they will be desirable, and if so, for whom. Nevertheless, the conceptual framework does seem to capture some major elements of the debates and issues over landscape and associated cultural changes.

2.3. Socio-ecological system components

While adaptive cycles and basins of attraction are useful concepts for characterising the overall dynamics of socio-ecological systems, to make progress in understanding the underlying processes resulting in such dynamics, it is necessary to consider the more fundamental components that make up such systems. The Sustainable Livelihoods framework, developed by the UK Department for International Development (DfID) and other organisations, provides a starting point. This framework sees such systems as being made up of elements of natural, physical, social, financial, and human capital, which, if in 'virtuous' relationships, tend to be linked in ways that reinforce capital accumulation. Based on a literature review and case study documentation, Selman and Knight (2006) summarise key elements in cultural landscapes in similar terms:

- ecological/natural capital – such as the 'life support systems' underlying biodiversity and natural resources;
- built/cultural capital – such as the structures and land uses that give relative degrees of character to parts of the countryside, and the cultures and traditions associated with particular areas;
- social/human capital – such as the networks and institutions that underlie trust and civicness, the potential for social learning within familiar and tangible settings, and levels of education and skills;
- economic capital – such as opportunities for the generation of wealth, jobs, business confidence and investment that are associated at least partly with natural and cultural landscape assets.

They also identified hypothetical but plausible links between these 'capitals', and conjectured how these links might operate more generally in sustainable cultural landscapes (Figure 2 below). This 'virtuous' relationship has been described elsewhere. It is often depicted for example in terms of high quality food and timber products, to which value is added locally, and which are often linked to tourism based on enjoyment of landscape, food and wine (e.g., Brunori and Rossi, 2000; Murdoch, 2000; Ventura and Milone, 2000; Hinricks, 2003; Sage, 2003). Policy measures now often seek to instil appropriate feedback loops in which there is sustainable mutual reinforcement between socio-economic development on the one hand, and environmental multi-functionality on the other. The Countryside Agency's *Eat the View* programme in England is an example of this approach. However, as already mentioned, it also should not be forgotten that land use and community dynamics can sometimes unwittingly be coupled in a 'vicious circle' of landscape deterioration and loss of multi-functionality, highlighting the need to explore 'virtuous' feedback processes more rigorously if they are to form a sound basis for entrepreneurship and policy intervention.

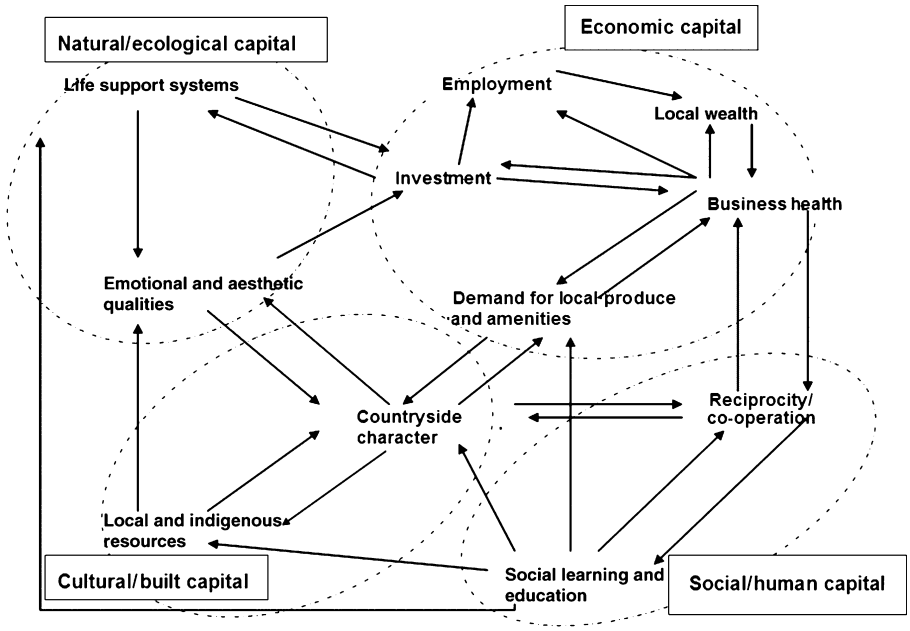

Figure 2. Hypothetical causal links within a cultural landscape. From Selman and Knight (2006) (modified).

3. Modelling landscapes as socio-ecological systems

3.1. What sort of models do we need?

We noted previously that various modelling approaches are now available for investigating change in socio-ecological systems and linking these to policy options. Despite their availability, however, these models have not yet been applied convincingly to the task of informing and evaluating agricultural and other rural policies to deliver dynamic, sustainable landscapes, largely due to their lack of comprehensibility and transparency to decision-makers. It is essential, therefore, that the future development of such models addresses this issue. However, the issue of model complexity poses a dilemma. On the one hand, there is the general preference of decision-makers for simple explanations (Couclelis, 2002) so that they can justify decisions without getting entangled in the intricacies of highly complex systems. On the other hand, there is no escaping the fact that socio-ecological systems are complicated systems involving interacting components, adaptation, and non-linear behaviour (Bak, 1994). Certainly the complex nature of such systems requires sufficiently detailed models to be developed.

To address this dilemma, we would argue that at least two types of approach to modelling landscapes are required. First, recognising that decision-support tools need to be accessible to a range of stakeholders, we consider a simple qualitative approach that can be applied in participatory settings, yet which still captures key aspects of landscape 'capitals', and positive and negative feedback. This more 'user-friendly' approach could enable professional and lay stakeholders to participate in modelling experiments to identify and anticipate the consequences of both intrinsic

and policy-driven change (e.g., van den Belt, 2004). Second, accepting that the ideas and principles arising from simple models can be formalised in more sophisticated ways for research and policy development, we turn to a quantitative approach, which aims at understanding the dynamic processes of socio-ecological systems to provide a basis for managing system trajectories towards desirable basins of attraction, possibly with the assistance of targeted policy support or through institutional change and adaptation (e.g., Harvey, 2003). Comprehensibility and transparency in this case could be addressed by consulting stakeholders regarding the purpose of the model and its assumptions. We see these two modelling approaches as being complementary – ideas and principles arising from each can be used to inform the other.

3.2. A simple qualitative approach

A qualitative, soft systems model can be invoked in the first instance in order to identify and investigate the nature, direction and strength of feedback relationships between different sub-components of a system. Bodini *et al.* (2000), for example, investigated feedback loops between economy, tourism, conservation and recreation in marginal aquatic landscapes in the Po Valley in Italy. Their analysis was especially helpful in illuminating complex relationships between protection effort and local income. A next step would be to confirm the nature, strength and direction of these links, the degree to which they might operate in a self-organising and self-reinforcing effect on landscape functionality, and the impact of public intervention in tipping the balance of the system to a 'desired' basin.

We recognise that approaches based on reinforcing links between local products and services, and local landscapes, may be most appropriate for a 'conservation' strategy, where the aim is to reinforce 'virtuous' linkages in order to sustain 'status quo' or 'recent past' conditions. However, for systematic landscape research and planning – whose objectives may range from strict conservation to the uncharted creation of new environments – more comprehensive simulation models, as test beds or virtual laboratories, are needed to operationalise the 'indicative' approach outlined above. These need to be sufficiently robust and quantifiable to accommodate more radical changes of state, and to characterise 'vicious' as well as 'virtuous' tendencies.

3.3. A simulation approach: incorporating people and institutions

A persistent criticism of landscape ecological models has been their overemphasis on ecological processes and patterns, and hence their production of relatively 'people-less' scenarios (Hawkins and Selman, 2002). Even the 'soft systems' approach described in Section 3.2, while incorporating human characteristics such as wealth and social learning, does not explicitly model people, or groups of people, as entities. However, the dominant factor in the dynamics of SESs, compared with other ecosystems, is the presence of humans, with their ability to remember and learn from the past, to perceive both current and future states of their biophysical and social environment, to communicate with each other, and to establish institutions that govern their behaviour so that specific goals can be achieved and undesirable outcomes prevented.

Many existing models of decision-making are based on economic cost–benefit principles which assume that, on average, a system behaves as if it consisted of

rational, self-interested individuals making decisions to optimise use of resources to meet certain goals. However, actual behaviour deviates substantially from the simplified 'rational' behaviour model (Selten, 1991), and predictions from such models are often unreliable (Moss *et al*., 2001). Moreover, such models cannot easily account for the variation in individual behaviours within landscapes and associated cultures. An example of this has already been mentioned above in relation to the slowness of uptake of agri-environment schemes due to the age-related reluctance of farmers to change their existing mode of farming despite it being economically rational to do so. Part of this reluctance is due to the status they have built up within the community over the years as 'good farmers', which they perceive may be compromised by the introduction of 'untidy' parts to their farms (Burton, 2004). To account for this behaviour within models, it is necessary that individual variations as well as social influences are incorporated.

Human institutions also need to be reflected in models, as these play a key role in the dynamics and resilience of SESs (Adger, 2000). Institutions, defined here in the wider sense, are humanly constructed constraints that structure interactions between people and their environment, and include formal constraints (rules, laws, constitutions), informal constraints (norms of behaviour, conventions, and self-imposed codes of conduct), and their enforcement characteristics (North, 1994). More voluntary collective behaviour also needs to be accommodated: for example, Ostrom's concept of institutions organized and run by resource users themselves, and social networks, which contribute significantly to resilience and adaptivity by creating conduits for information flows (e.g., Deffuant *et al*., 2002) and some financial flows. The structure of social networks is likely to have a major influence on the way that SESs function – recent work on the theoretical aspects of network structure, particularly 'small-world' (Watts and Strogatz, 1998) and 'scale-free' (Barabási *et al*., 2000) networks, and how this structure influences network resilience, is particularly relevant.

A rapidly emerging opportunity to incorporate more realistically into models these characteristics causing deviation from purely economic rational behaviour is afforded by agent-based modelling (ABM). Originating from the field of artificial intelligence, agent-based models consist of a number of 'agents' representing decision-making entities, which interact both with each other and with their environment, and which can make decisions and change their actions as a result of this interaction (Ferber, 1999). Agents may contain their own 'picture' of their environment (which may not necessarily be complete or even true) built up from their interactions with it. The behaviour of the whole system depends on the aggregated behaviours of individual agents. ABM has aroused the interest of the land-use modelling community, mainly because it offers a way of incorporating the influence of human decision-making on the environment in a mechanistic and spatially explicit way, taking into account social interaction, adaptation, and multiple scales of decision-making. Such models offer a way of exploring the impact of 'virtuous' links between different entities in the system. Through a better understanding gained in this way, it may be possible to design and evaluate policies which nudge SESs away from undesirable basins of attraction towards desirable basins.

One of the earliest uses of ABM in relation to land use and institutions was the study of Lansing and Kremer (1993), who modelled rice production systems in Indonesia aimed at balancing the two opposing constraints of water-sharing and

pest control. Assuming only that farmers obeyed simple rules of imitating the time of planting of their neighbours that gave the highest yields, Lansing and Kremer were able to show how robust planting and irrigation schedules emerged, which were able to produce high yields and withstand ecological perturbations due to drought and pest attack. Such schedules matched closely those observed in real life mediated by religious rituals at 'water temples'.

A number of such agent-based land-use models are now beginning to appear (see a recent review by Parker *et al*., 2002). Many involve the grafting of a multi-agent system, representing a number of households, onto a cellular automata 'landscape', with each agent being linked in some way to the cells over which it has influence. An example of such a model is the People and Landscape Model which has been used to investigate the survival characteristics of different crop nutrient strategies, including the sale and purchase of excess organic manure between households (Matthews, 2006). At their current level of development, ABMs are probably more useful as tools to *explore* options for effecting change in landscapes and rural communities, rather than *predicting* them, and as such, it is important that the structure of the models and the assumptions incorporated into them are transparent, and therefore well-documented, and also that the mechanistic behaviours assumed for the agents are well grounded in actual behaviour patterns.

Although the inherent complexity of ABMs means that their prime use for the time being is likely to be for research purposes, there is a growing recognition of the need to improve their relevance by integrating modelling and deliberation with the public, particularly stakeholders and potential users of model outputs (Ramanath and Gilbert, 2004). In relation to ABMs, Parker *et al*. (2002) distinguish three levels of participation: (a) where stakeholders are involved at all stages of model development, including model conceptualisation, building and use, (b) where stakeholders are not involved in model building, but are involved in model running, and (c) where models are presented to policy makers as ready-made software packages with the ability for the users to alter model parameters to test various policy options. ABMs may have particular advantages in a participatory context, as the agents can be made to represent individuals or groups with whom stakeholders can identify. The latter can therefore criticise the models or contribute to their design in ways that make use of their practical knowledge. Several examples describing the use of ABMs as a tool in participatory role-playing games to solve specific problems are given by Bousquet *et al*. (2002) However, participatory modelling should not been seen as a panacea, as it does have its downsides; these include the time and cost of involving stakeholders, possible bias in the stakeholders selected resulting in a poorer representation of the real-world system, and lack of academic credibility of the resulting models. Difficulties in validating such models is a particular issue, although greater 'buy-in' and trust in a model by the participants may be more important in this context than its numerical accuracy (van den Belt, 2004). In this way, ABMs can provide a focus for debate by testing hypotheses and analysing 'what-if' scenarios.

3.4. Incorporating policy impacts

A final requirement concerns the need to incorporate plausible policy measures more effectively within models, and to assess whether they help stabilise a landscape

within a desirable basin of attraction, or help shift it towards a desirable new one. Policies can be seen in most cases as external influences on a socio-ecological system, affecting the decisions made by the agents it contains. This can be by placing constraints on the range of all possible decisions through, for example, legislation, or by altering the flow of financial capital upon which the agents base their decisions, through, for example, taxes or subsidies. We are then interested in the way in which these resulting decisions and subsequent actions impact on the processes maintaining a current landscape or those leading to future landscapes. For example, an important question related to the resilience of the SES is to what extent changes brought about by a particular policy are sustainable – if the policy is removed, does the system revert to its previous basin of attraction, or does it remain in its new one? It may be that certain desired landscapes can only be achieved through continual injection of external resources to maintain them in a 'far-from-equilibrium' state (Kay *et al*., 1999).

A second question is whether a particular valued landscape can be preserved without destroying its necessary integrity and connectivity between the occupants, participants, and the surrounding socio-economic and environmental systems. For example, many current policies seek to intervene in various ways intended to re-localise certain practices (e.g., supporting the family farm, requiring corporate developers to observe vernacular built design elements, and instigating participatory decision-making processes). While there are well-developed 'localisation' arguments which favour the re-embedding of production into places, there are equally convincing arguments concerning the connectivity which 'globalisation' affords between distant producers and consumers. Thus, some of our conservation measures, while not sustainable in the longer term, may be better seen as temporary palliatives to gain breathing space whilst we reassess exactly what a valued landscape means, what it should contain, and how it should be achieved and maintained. It may well be that, as a result of this process, some of our landscape features will join the collective 'palimpsest', with something else replacing them and only their traces remaining. This is essentially what Westmacott and Worthington (1976) proposed a generation ago, when they advocated creating new agricultural landscapes, different from, but not necessarily less interesting than, the ones they replaced. If particular valued inherited landscapes are to be retained, then this requires that ways are found of maintaining the circle of virtuosity between people and place, which could include some level of re-localisation of governance, economy, community, and ecosystem. However, these will need to be coupled to a blend of global, regional and local 'drivers' if they are to be sustainable in the long term. Here, innovations in modelling can inform policy-makers about the possibilities and likely consequences of different policy choices.

4. Conclusion

We have put forward the idea that cultural landscapes are dynamic 'socio-ecological systems', made up of social, economic and biophysical components interacting together. The concept of a virtuous circle, in which there are feedbacks between humans and their biophysical environment resulting in positive outcomes, is a useful conceptual model which has parallels with the adaptive cycle concept of Gunderson and Holling (2001). The challenge now is to see whether these concepts of virtuous circles, adaptive cycles, basins of attraction, and stability landscapes can be

modelled in the UK context, and whether such efforts can be of positive use to decision-makers and practitioners.

One use would be to evaluate the main argument in this paper that current policy instruments for virtuosity in cultural landscapes tend to emphasise the role of traditional farming methods and local foods in maintaining familiar habitats, but that, important though this may be, it is insufficient as a general basis for sustaining resilient socio-ecological systems. Thus, virtuosity should refer not necessarily to the conservation of traditional land uses and artefacts in heritage landscapes, but also to the stabilisation of new socio-ecological systems. We suggest that future landscapes need to possess a degree of interdependency between socio-economic capital and environmental capital that cultivates a self-sustaining relationship between wise environmental stewardship and consequent ecological resilience, possibly with very different values and patterns from current or conserved landscapes. Creative policy shifts such as these need to be supported by an improved understanding of the probable direction and intensity of feedback effects, and the likely consequences of moving between alternative basins of attraction.

This suggests a number of research questions:

- What measures can reinforce or re-instil a virtuous circle between the capitals underlying a cultural landscape in order to maintain it in a desirable state? A range of current initiatives based on an embedded 'territorial repertoire' of products and services is now beginning to provide us with a range of evidence on this issue.
- Where and in what degree is re-localisation necessary and achievable to resist the trend of exogenous pressures, and where and how can the forces of globalisation contribute positively to landscape resilience and stability? Although re-localisation is clearly impossible as a general solution, some applications of it may be appropriate in pursuing particular landscape objectives, such as the retention of key habitats through carefully prescribed farming practices.
- Can we establish where in a basin of attraction a particular system is located, and how close it might be to a threshold and transformation into another basin of attraction?
- Where a current landscape cannot be conserved because of natural environment change (e.g., marine transgression, shifting species ranges), or if we consciously intervene to create an alternative future landscape, what can we do to predispose the system to shift into a preferred alternative basin of attraction?

To address these questions, we propose that future research needs to focus on dissecting the processes occurring within rural systems in order to understand how they interact together to contribute to overall system dynamics. Part of this research needs to reassess what we mean by a valued landscape – values change over time and sometimes need to be challenged, especially if it can be demonstrated that new landscape options are more sustainable and multifunctional than inherited ones. This implies that ways need to be developed of engaging a range of stakeholders, including farmers, tourists, decision-makers, and scientists, in understanding, debating and delivering landscape choices. Modelling needs to play a central role in the whole process by providing a framework to draw together data and knowledge from a range of disparate sources, and consequently to allow exploration of different hypotheses of how systems can be changed, before such changes are inflicted on real people.

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